Center Innovation Fund: AFRC CIF

Optimized Lift for Autonomous Formation Flight (OLAFF)

Completed Technology Project (2011 - 2012)

Project Introduction

Experimental in-flight evaluations have demonstrated that the concept of formation flight can reduce fuel consumption of trailing aircraft by 10 percent. Armstrong researchers have developed a peak-seeking control algorithm that can increase this efficiency by another 2 percent. The innovation works by optimizing, in real time, the lift distribution across the wing of an airplane flying within the wingtip vortex of another airplane. Conventional trim schedules use anti-symmetric (equal but opposite between the left and right wings) aileron deflections to counter roll asymmetries and keep the wings level. In formation flight, however, this approach can “dump” lift near the wingtip where the vortex effects are greatest, reducing the amount of benefit gained. The peak-seeking solution instead uses all available control surfaces across the span of the wing (including wing flaps used for landing) as required to find the best solution to maintain trimmed flight within the vortex.

Work to date: The research team has developed a multi-vehicle transport-class aircraft simulation that includes probabilistic models of the wind-drift and descent of aircraft wakes, the aerodynamic interference effects of wingtip vortices on other aircraft, and formation guidance and control laws. The team has also developed a roadmap for the maturation of formation flight technology to Cooperative Trajectory operations; that is, commercial transport aircraft operations at extended distances of 1-2 nautical miles.

Looking ahead: The group is developing a flight experiment to demonstrate drag reduction through cooperative trajectories using commercial, off-the-shelf avionics systems, including ADS-B data link technology. The experiment is expected to fly in 2015.

Benefits

- **Efficient**: Improves fuel savings in formation flight by an additional 2 percent
- **Economical**: Achieves objectives with existing control surfaces
- **Saves time**: Allows airplanes to fly closer together, reducing airspace congestion

Applications

- Reduced cost for commercial passenger and cargo aircraft operations
- Extended range for military aircraft
- More efficient multi-vehicle, cooperative applications for drone aircraft

Optimized Lift for Autonomous Formation Flight

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Armstrong Flight Research Center (AFRC)

Responsible Program:

Center Innovation Fund: AFRC CIF

Anticipated Benefits

- **Efficient**: Improves fuel savings in formation flight by an additional 2 percent
- **Economical**: Achieves objectives with existing control surfaces
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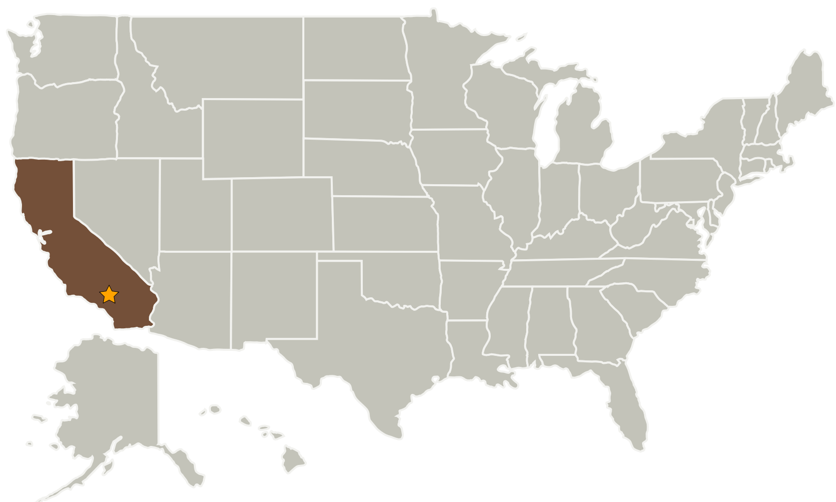
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Armstrong Flight Research Center(AFRC)	Lead Organization	NASA Center	Edwards, California

Primary U.S. Work Locations
California

Project Management

Program Director:

Michael R Lapointe

Program Manager:

David F Voracek

Principal Investigator:

Curtis E Hanson

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - └ TX15.1 Aerosciences
    - └ TX15.1.6 Advanced Atmospheric Flight Vehicles